Teaching, Learning, and One-to-One Computing

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Abstract

High levels of access to technology are transforming schooling. The nature of that transformation is still evolving, but its outlines are emerging. The types of learning activities are different. Attitudes toward school are different. Relationships between school and the community change. There are also new tensions that arise, such as conflicts between new learning models and old policy models, and between new outcomes and old assessments. This paper outlines the scope of this transformation and suggests some strategies for taking advantage of its potential for helping schools and students succeed.

Context

"High-access" is sometimes referred to as "one-to-one" (one person per computer) or "ubiquitous computing." These concepts are not necessarily the same. For instance, as envisioned by pioneers in the field, such as the late Mark Weiser, "ubiquitous" was intended to mean an environment that is explicitly *not* "one-to-one," but rather one in which an individual interacts with multiple computers in many settings: an environment so infused with digital processing that the bulky electronic furniture and luggage that now defines desktop and laptop computing is no longer necessary (Weiser, 1999). A cell phone or GPS unit interacting with digital devices in the environment is closer to the ubiquitous vision than is a full-featured laptop. The point is that we are discussing a concept that is in the process of being defined, and policies and practices (including those suggested in this paper) have to be considered provisional.

Another important point is that many schools are not waiting for the concept to be fully defined, but are moving ahead to provide whatever access and advantages they can using existing technologies. The web site of the Ubiquitous Computing Evaluation Consortium (http://www.ubiqcomputing.org/) cites 34 reports from 2003-2005 of ongoing large and small laptop programs ranging from single-school projects up to statewide initiatives involving tens of thousands of students. In addition, the site notes reports from 125 independent schools in the U.S., Australia, Canada, and India, and the site is beginning to track handheld computing projects. A general Internet search indicates that this is a fraction of the projects currently underway worldwide, and some of these efforts have been underway for 20 years (Keefe & Zucker, 2003). This suggests that emergent practice is the norm in this field, and educational policies and recommendations need to be developed to keep up with a dynamic environment.

Benefits of Laptop and Handheld Computing

What educational pressures drive the current interest in high-access computing? The literature suggests that educators look to "one-to-one" programs to provide resources to students, motivate students, and, as a result, improve outcomes. Table 1 summarizes findings that have been documented in published evaluation reports from recent studies.

Table 1. Reported advantages of laptop and handheld computing.

Finding	Reported In*	Example
Attendance and discipline rates improve.	Knezek & Christensen, (2005); Light et al. (2002); Zucker & McGhee, (2005)	Discipline referrals in Texas schools participating in a laptop initiative dropped, while referral rates in comparison schools increased. (Knezek & Christensen, 2005)
Students access a broader array of learning resources and experiences (including increased collaboration with others and increased use of technology for learning).	Lane (2003); Light, et al. (2002); Vahey & Crawford (2002); Walker et al. (2000); Zucker & McGhee, (2005)	Increased use of technology for educational use in school and at home; improved scores on writing assessment in the Microsoft/Toshiba Learning Anytime Anywhere Pilot (Walker et al., 2000).
Relationship between teacher and student changes	Bobkoff & Kratcoski, (2004-2005); Honey (2001); Sargent (2003); Light et al. (2002). Owen et al. (2005-2006); Zucker & McGhee, (2005)	Students and teachers report increased frequency and quality of supportive individual and group interactions (Light et al., 2000).
Student attitudes toward school improve.	Lane 2003; Vahey & Crawford, (2002); Swan et al. (2005); Zucker & McGhee, (2005)	Students and teacher survey responses show increased enthusiasm for school work in classes among participants in Palm's Education Pioneers program (Vahey & Crawford, 2002).
Parent attitudes toward school improve.	Rockman (2003); Zucker & McGhee, (2005).	In schools participating in laptop programs, parent involvement and communication increases (Rockman, 2003).
Student achievement increases.	Gulek & Demirtas, (2005); Light et al. (2002); Muir et al. (2004); Swan et al. (2005); Walker et al. (2000).	Schools implementing Maine's laptop initiative for three years had significantly higher test scores than comparison schools in Science, Math, and Visual/Performing arts. (Muir et al., 2004).

*See the reference list for complete citations.

In addition to these benefits, ubiquitous technology also facilitates other aspects of school operations. Although there are various technical hurdles in converting to wireless networks, wireless technology also solves certain technical problems inherent in physical wiring (Nair, 2002). Besides students having ready access to resources, teachers and

administrators using mobile devices have ready access to information on student achievement, school schedules, and other information necessary for data-driven decision making (Daniell et al., 2005; Honey, 2001).

Barriers

Despite these advantages, the use of new technology does not necessarily result in improved outcomes. Even when intermediate goals (such as changed attitudes and student roles) are achieved, this does not necessarily result in higher academic achievement measures (Walker, Rockman, & Chessler, 2000; Rockman, 2004). Issues with technology, support, and logistics can affect instruction. (Owen et al., 2005-2006; Shields & Poftak, 2002; Warschauer & Grimes, 2005). The work of this author and his colleagues on laptop initiatives in Virginia and Texas documented issues including:

- Laptop batteries only last one or two school periods. They cannot be used every period of the day in school unless each unit has its own power supply and the classrooms are equipped with enough power outlets.
- Laptops require more technical support than do desktop units. They are less modular, so a problem with one component, such as a monitor, sidelines the unit. Because they are mobile, they may be subject to more abuse than are stationary machines.
- Laptops and handhelds are not truly mobile unless they are able to connect to the Internet and to school local area network resources throughout the school building and from remote sites. This requires establishing a wireless network in the school, and may require rethinking school policies on security and off-site use of school district property.
- Mobile computing, and mobile labs require additional technical training. Teachers generally do not come into a laptop-equipped classroom with the knowledge to be lab managers as well as educators.
- As with any technology, the effects on teaching and learning depend on integration with curriculum and instruction. In surveys and interviews, teachers often say they need examples of effective technology-based learning activities and curriculum resources. (Bielefeldt et al., 2005; Bielefeldt & Beaver, 2003).

All of these are solvable problems: hardware can be purchased, technicians can be hired, teachers can be trained, and so forth. However, taken together, they present a daunting challenge in terms of classic implementation factors (Fullan, 1992) and the essential conditions for technology integration (International Society for Technology in Education, 2000), including infrastructure, technical and training support, policy, funding, and a well-understood vision for technology's role in teaching and learning.

Research Issues

Another barrier to these emerging technologies is that they can be difficult to study. The novelty and complexity of the technology may mean that implementation of any intervention will change over time and in different physical and organizational environments. Studies have shown that the introduction of high-access computing can change the nature of instruction (Fisher et al., 1996), and the strategies learned with technology may not be the same ones required for standard assessments of learning (Means & Olson, 1995).

A comprehensive research strategy would take into account the several goals of education and technology as well as how the technology is integrated into teaching and learning. Zucker (2004) proposes a research framework for 1:1 computing in which studies are focused on

- critical features of a 1:1 initiative (e.g., goals, technology used);
- the resulting interactions and intermediate outcomes (e.g., changes in instruction or systemic nature of schools); and/or
- ultimate outcomes (e.g., student learning, economic competitiveness).

Each stage of the framework is subject to evaluation, and different methods and evidence may be appropriate at different stages. This proposal mirrors standard evaluation logic modeling (Worthen et al., 1997) and is in contrast to input/output models that look for a relationship between technology access and learning outcomes without detailed assessment of the intervening implementation and integration. In general, findings from these types of studies (which often involve mining large data sets) vary with the extent to which the analysts drill down to discover the nature of technology use (e.g., Wenglinsky, 1998; Fuchs & Woessmann, 2004). However, the level of detail is often inadequate to accurately describe teaching and learning activities (Bielefeldt, 2005). As with the implementation issues, these issues are solvable in theory. A wide range of instruments have been developed to assess technology integration (International Society for Technology in Education, 2003, 2006). Such detailed evaluation of technology integration can be expensive and add further burdens to educators who may already be striving to meet state or district-mandated assessment requirements.

Future Vision

In 2004, the NetDay organization sponsored an informal online survey of K-12 students. More than 55,000 students responded to the question, "What would you like to see invented that you think will help kids learn in the future?" Researchers from the U.S. Department of Commerce reviewed 8,000 of these answers and synthesized a profile of the ideal learning tool. According to this profile, the tool would be:

- Small, handheld, wireless, and voice-activated.
- It would allow access to kid-friendly web sites, with no ads.
- It could be used to complete school assignments, participate in online classes, play mathematics learning games and read interactive textbooks, interact with

digital tutors and information data banks, and participate in educational virtual reality experiences. (Technology Administration, 2005).

It would, in other words, connect the student to a world full of digital resources--a ubiquitous computing environment that begins to approach the vision of the pioneers in the field.

Combining these student-described features with the adult-defined benefits outlined in Table 1, we come up with devices that also:

- Are accessible to all students (i.e., are inexpensive to buy or are provided by the school).
- Have the electronic means and organizational permission to connect to network resources (e.g., can share information easily with school fileservers without jeopardizing network security.)
- Connect to parent and community resources (e.g., can interact with homework hotlines or attendance notices).
- Support formats and media in line with curriculum (e.g., operating systems that support common word processing software and screen and input devices suitable for reading and writing).

Obviously, there will need to be some negotiation between the student desires and the adult expectations. There will also need to be some very serious negotiations between the adults who administer the learning and technology environment of schools. To take advantage of ubiquitous networked information and communication devices, that environment would need to support and coordinate communication between and among its stakeholders. For ubiquitous computing, that may be the greatest challenge and at the same time, the greatest potential contribution.

References

Bielefeldt, T. (2005). Computers and student learning: Interpreting the multivariate analysis of PISA 2000. *Journal of Research on Technology in Education, 17*(4), 339-348.

Bielefeldt, T., Daniell, D., Schneidmiller, J. & Beaver, S. V. (2005). Loudoun County Public Schools Laptop Pilot Evaluation. Eugene, OR: ISTE.

Bielefeldt, T. & Beaver, S. V. (2003). Wireless Integration Now: Evaluation Report. Eugene, OR: ISTE.

Bobkoff, K. & Kratcoski, A. (2004-2005, Winter). Teacher-student interactions in a ubiquitous computing environment: Learning within dyads & triads of interaction. *Journal of the Research Center for Educational Technology*, Winter 2004-2005. Retrieved December 29, 2005 from http://www.rcetj.org/?type=art&id=2420.

Gulek, J. C. & Demirtas, H. (2005, January). Learning with technology: The impact of laptop use on student achievement. *Journal of Technology, Learning, and Assessment,*

3(2). Retrieved December 29, 2005 from http://www.bc.edu/research/intasc/jtla/journal/v3n2.shtml

Daniell, D., McNabb, M., Bielefeldt, T., & Schneidmiller, J. (2005). LEADing the Future: Summative Evaluation Report. Eugene, OR: ISTE.

Fischer, C., Dwyer, D. C., & Yocam, K. (1996). *Education and technology: Reflections on computing in classrooms.* San Francisco: Jossey-Bass.

Fullan, M. G. (1992). *Successful school improvement.* Buckingham: Open University Press.

Goolsbee, A. & Guryan, J. (2002). The impact of Internet subsidies in public schools. NBER working paper series, No. 9090. Cambridge, MA: National Bureau of Economic Research. Retrieved January 2, 2006, from http://www.nber.org/papers/w9090

Honey, M. (2001). Exploring the potential for handheld technology for preservice education. New York: Education Development Center, Center for Children and Technology.

ISTE. (2000). *National Educational Technology Standards for Students: Connecting Curriculum with Technology.* Eugene, OR: Author.

Keefe, D. & Zucker, A. (2003, April). Ubiquitous computing projects: A brief history. Ubiquitous Computing Evaluation Consortium. Arlington, VA: SRI International, Inc.

Knezek, G. & Christensen, R. (2005). Student findings from the spring 2005 Irving laptop survey. University of North Texas, Institute for the Integration of Technology into Teaching and Learning.

Lane, D. M. M. (2003, April). The Maine Learning Technology Initiative: Impact on students and learning. Occasional Paper #1. University of Southern Maine Center for Education Policy, Applied Research, and Evaluation.

Light, D., McDermott, M., & Honey, M. (2002, May). Project Hiller: The Impact of ubiquitous portable technology on an urban school. New York: Center for Children and Technology.

Nair, P. (2002, October). The role of wireless computing technology in the design of schools. Washington, DC: National Clearinghouse for Educational Facilities. Retrieved December 29, 2005, from www.edfacilities.org/pubs/wirelessII.pdf

Owen, A., Farsaii, S., Knezek, G., & Christensen, R. (2005-06, December/January). Teaching in the one-to-one classroom. It's not about laptops, it's about empowerment! *Learning & Leading with Technology, 33*(4), pp. 12-16.

Perry, D. (2003, March). Handheld computers (PDA's) in schools. Becta ICT Research. Retrieved December 29, 2005 from http://www.becta.org.uk/page_documents/research/handhelds.pdf

Rockman, S. (2003, Fall). Learning from laptops. Threshold, pp 24-28.

Sargent, K. I. (2003, April). The Maine Learning Technology Initiative: What is the impact on teacher beliefs and instructional practices? Occasional Paper #3. University of Southern Maine Center for Education Policy, Applied Research and Evaluation.

Shields, J. & Poftak, A. (2002, February 15). A report card on handheld computing. TechLEARNING. Retrieved December 29, 2005 from http://www.techlearning.com/db_area/archives/TL/2002/02/handheld1.html

Swan, K., van 't Hooft, M., & Kratcoski, A. (2005). Uses and effects of mobile computing devices in K–8 classrooms. *Journal of Research on Technology in Education, 38* (1), 99-112.

Technology Administration (2005, August). *Visions 2020.2 Student views on transforming education and training through advanced technologies.* Washington, DC: U.S. Department of Commerce.

Vahey, P. & Crawford, V. (2002, September). Palm™ education pioneers program. Final evaluation report. SRI International. Retrieved December 29, 2005 from www.palmgrants.sri.com.

Walker, L., Rockman, S., & Chessler, M. (2000). A more complex picture: Laptop use and impact in the context of changing home and school access. The third in a series of research studies on Microsoft's Anytime Anywhere Learning Program. San Francisco, CA: Rockman, et al. Retrieved February 13, 2003,from http://rockman.com/projects/laptop/laptop3exec.htm.

Warschauer, M. & Grimes, D. (2005, October 20). First year evaluation report, Fullerton School District Laptop Program. University of California, Irvine.

Weiser, M., Gold, R., & Brown, J. S. (1999). The origins of ubiquitous computing research at PARC in the late 1980s. IBM Systems Journal, 38(4). Retrieved December 29, 2005 from http://www.research.ibm.com/journal/sj/384/weiser.pdf.

Wenglinsky, H. (1998). Does it compute? The relationship between educational technology and student achievement in mathematics. Princeton, NJ: Educational Testing Service. Retrieved June 1, 2006, from ftp://ftp.ets.org/pub/res/technolog.pdf.

Worthen, B. R., Saunders, J. R., & Fitzpatrick, J. L. (1997). *Program evaluation: Alternative approaches and practical guidelines.* New York, NY: Longman.

Zucker, A. A. (2004, January). Developing a research agenda for ubiquitous computing in schools. *Journal for Educational Computing Research. 30*(4) 371-386. Retrieved December 29, 2005 from http://ubiqcomputing.org/Research_Agenda_Jan_04.pdf

Zucker, A. & McGhee, R. (2004). A study of one-to-one computer use in mathematics and science instruction at the secondary level in Henrico County Public Schools. Menlo Park: SRI.